Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 10, October - 2025

Design of Sewerage Network for Hangal Town using Openflows SewerGEMS and QGIS

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***Abstract*—The growing demand for sustainable and efficient urban infrastructure requires the development of optimized sewerage systems that ensure cost-effectiveness, hydraulic efficiency, and environmental sustainability. This study focuses on the design and optimization of a sewerage network for Hangal Town using SewerGEMS software integrated with Geographic Information System (GIS) tools. GIS was applied to extract topographical and land-use data, enabling accurate alignment of sewer lines based on terrain elevation, population density, and urban growth patterns. Hydraulic modeling in SewerGEMS was carried out to analyze flow characteristics, pipe sizing, network layout, and pumping requirements, with optimization aimed at reducing energy use and construction costs. GIS-based mapping enhanced catchment delineation, identification of flood-prone areas, and determination of optimal sewer routes. Climate resilience measures were also incorporated to ensure long-term system reliability under future urban expansion and extreme weather conditions. The results demonstrate that integrating GIS and SewerGEMS significantly improves sewerage planning, reduces overall costs, and enhances hydraulic performance. The study contributes to the advancement of smart wastewater management systems by combining computational modeling with geospatial analysis for efficient and sustainable infrastructure design.**

***Keywords*— SewerGEMS, QGIS, Manholes, Sewer Network, Rural Areas.**

I INTRODUCTION

Sewerage systems form an essential component of urban infrastructure, ensuring the safe collection, conveyance, and disposal of wastewater. An efficient sanitation framework is vital for environmental sustainability and public health, as untreated sewage often leads to water pollution, waterlogging, and outbreaks of waterborne diseases. In India, where urban areas are rapidly expanding, the design of sustainable sewerage networks has become a pressing challenge.

Traditional sewer planning methods are labor-intensive and limited in accuracy. With increasing population density and urbanization, modern computational and geospatial tools are required to achieve optimized designs. SewerGEMS, a specialized hydraulic and hydrological modeling software developed by Bentley Systems, offers advanced features for flow simulation, pipe sizing, and network optimization. Its integration with Geographic Information System (GIS) platforms such as QGIS enhances spatial accuracy by incorporating topographical, demographic, and land-use data. This combination allows engineers to design networks that are hydraulically efficient, cost-effective, and adaptable to future growth.

Hangal Town, located in Karnataka, has witnessed significant population growth, resulting in increased wastewater generation and sanitation challenges. The present study addresses these issues by designing a sewerage network using SewerGEMS integrated with GIS. The methodology involves hydraulic modeling, capacity analysis, rainfall data incorporation, and population forecasting to ensure that the system meets both present and future demands.

Integrating SewerGEMS with GIS allows precise hydraulic modeling and spatial planning, enabling engineers to optimize pipeline layouts, simulate various scenarios, and plan for future growth. This approach not only reduces construction and maintenance costs but also ensures that the sewerage network can meet both current and projected demands.

The significance of this study lies in its ability to deliver a sustainable and optimized sewerage plan, reducing construction and operational costs while maintaining compliance with environmental standards. By employing advanced computational tools, the project demonstrates how modern technology can contribute to smart urban wastewater management

A. OBJECTIVE OF THE STUDY

1. To collect vital information on population, RLs, topography, and groundwater tables in order to create a thorough report outlining the project's parameters and requirements.
2. To use Bentley's SewerGEMS software to evaluate the flow of sewage in a particular area before designing and analyzing an effective sewerage system with a focus on hydraulics and hydrology
3. To create a well-functioning and eco-friendly drainage system for Hangal town.
4. To use SewerGEMS software to check how the system will work and flow in real conditions.
5. To plan the sewer lines smartly by looking at the land’s slope and how many people live in each area.
6. To make sure the system is designed to accommodate future expansion and follows environmental rules.
7. To use location-based data (like maps) to design the system more accurately.

II LITERATURE REVIEW

A. General

The design of sewerage networks is a key component of urban infrastructure, ensuring efficient wastewater management and environmental protection. Traditional design methods are time-consuming and prone to errors, whereas modern computational tools provide faster and more reliable results. SewerGEMS, a hydraulic and hydrological modeling software, supports engineers in pipe sizing, slope adjustments, flow analysis, and optimization. Its integration with GIS platforms further improves accuracy by incorporating terrain, land use, and population data. This review presents key studies that demonstrate the use of SewerGEMS and related approaches for sewer network planning.

B. Literature Studies

Christopher et al. (1986**)** developed one of the earliest computer-based sewer models, calibrated for both dry and wet weather conditions, showing the importance of simulation for future planning.

Patanwal and Malek (2015) emphasized that safe water supply and sanitation are basic public needs. They highlighted inconsistencies in sewerage design standards and recommended uniform guidelines for reliable planning.

Katti et al. (2015) demonstrated that SewerGEMS reduces cost and time by optimizing sewer alignment and hydraulic parameters such as diameter, slope, and velocity.

Noori and Singh (2017) combined GIS data with SewerGEMS modeling to design decentralized wastewater systems. Their study showed that GIS integration enhances spatial accuracy and supports sustainable solutions.

Sopariya et al. (2018) concluded that manual design methods are cumbersome, while computational models like SewerGEMS provide accurate hydraulic analysis and easy design modifications.

Kulkarni et al. (2021**)** used SewerGEMS integrated with QGIS to design urban wastewater systems, highlighting its role in handling rapid population growth and urbanization.

Padgaonkar et al. (2023) and Pande et al. (2024) have focused on climate resilience and future expansion, showing that advanced tools like SewerGEMS allow scenario analysis and performance evaluation for sustainable urban sewer planning.

C. Research Gap and Relevance

The literature highlights that:

- SewerGEMS integrated with GIS improves design accuracy and efficiency.
- Most past research is based on larger cities, with limited applications for medium-sized towns like Hangal.
- Few studies combine population forecasting, cost analysis, and climate resilience within a single sewerage project.

III METHODOLOGY

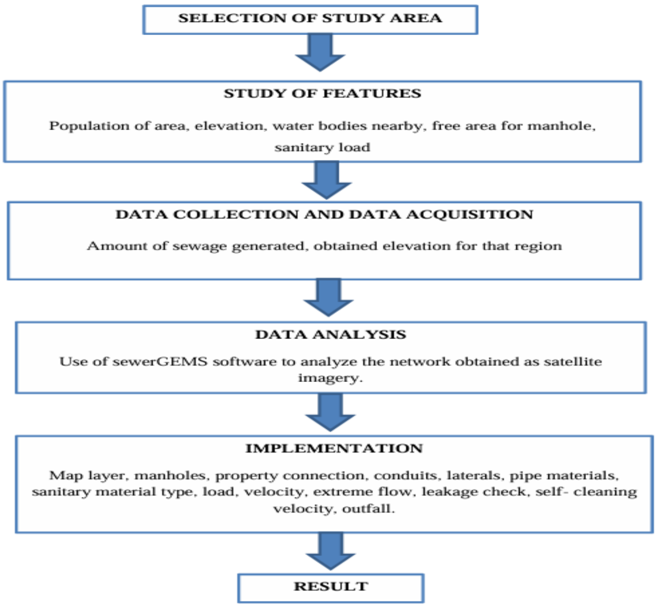

Fig.1. Methodology flowchart showing the modelling of a sewerage network

A. Study Area – Hangal Town

Hangal Town, located in Haveri District of Karnataka, was selected as the study area for the present work. The town has been experiencing rapid population growth, leading to increased wastewater generation and sanitation challenges. The geographical extent of the study area was delineated using QGIS software, which provided spatial information such as topography, elevation, and slope required for sewer network planning.

Fig. 2. Study area selected

B. Data Collection

For the design of the sewerage network, essential data were obtained from Census of India (2011), IS 1172:1993 – Code of Basic Requirements for Water Supply, Drainage and Sanitation, and the CPHEEO Manual. The major parameters include population, water demand, and sewage generation.

- Base Year Population (2011): 28,159 (Census of India, 2011)
- Water Supply Rate: 135 LPCD (IS 1172:1993)
- Sewage Factor: 0.8 (80% of water supplied becomes sewage)
- Population Projection Method: Arithmetic Increase Method, with an average increase of 415.9 persons/year based on 2001–2011 growth.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 10, October - 2025

The sewage flow (Q) is estimated using the formula:

$$Q = (P \times 135 \times 0.8) / 1,000,000 \text{ (in MLD)}$$

TABLE I. POPULATION PROJECTION AND SEWAGE FLOW

Year	Population (P)	Sewage Flow (MLD)	Remarks
2011	28,159	3.04	Base year (Census 2011)
2025	33,982	3.67	Design year (14 yrs after 2011)
2055	46,459	5.02	Future Design year

C. Software Tools Used

a.SewerGEMS

SewerGEMS was used for hydraulic modeling of the sewerage network. The software enables pipe sizing, slope calculation, flow simulation, and network optimization. Scenario management was applied to test the system under different population and flow conditions.

b. QGIS

QGIS was used for spatial data processing, including preparation of base maps, terrain analysis, and slope mapping. Catchment delineation and manhole location planning were carried out in QGIS before integration with SewerGEMS.

D. Hydraulic Simulation (SewerGEMS)

The forecasted sewage loads were applied in SewerGEMS to simulate the sewer network. The software analyzed the hydraulic behavior of conduits and manholes under projected flow conditions.

- Minimum Pipe Diameter: 150 mm (as per CPHEEO guidelines).
- Hydraulic Parameters: Manning's roughness coefficient $n = 0.013$; velocity maintained in the range of 0.6–3.0 m/s to ensure self-cleansing and prevent scouring.
- Design Flow: Peak factor of 2.5 applied to average flows for maximum discharge capacity.
- Final Design: A trunk sewer of 1800 mm diameter was adopted to carry the ultimate design load of 2055.
- Manholes**:** Provided at 30–50 m spacing, with depths adjusted according to terrain variations.

The simulation confirmed that the designed sewer network meets hydraulic efficiency standards and ensures safe conveyance of sewage for both present and future populations of Hangal Town.

IV IMPLEMENTATION

A. QGIS was used for spatial data processing, including preparation of Digital Elevation Map, Hill Shade Map, Soil Texture Map, Contour Map, and Land Use Land Cover Map. The layers were digitized and integrated to generate the base for pipeline network mapping

The step-by-step procedure adopted in QGIS for preparing thematic maps and pipeline network mapping is shown in Figure

Fig.3. Step-by-step GIS mapping workflow in QGIS

B. SewerGEMS was used for hydraulic modeling. The process involved importing base maps, defining manholes and conduits, assigning pipe sizes, materials, and sanitary loads. Hydraulic simulation was then performed to analyze the network under different flow conditions**.**

The step-by-step procedure adopted in SewerGEMS

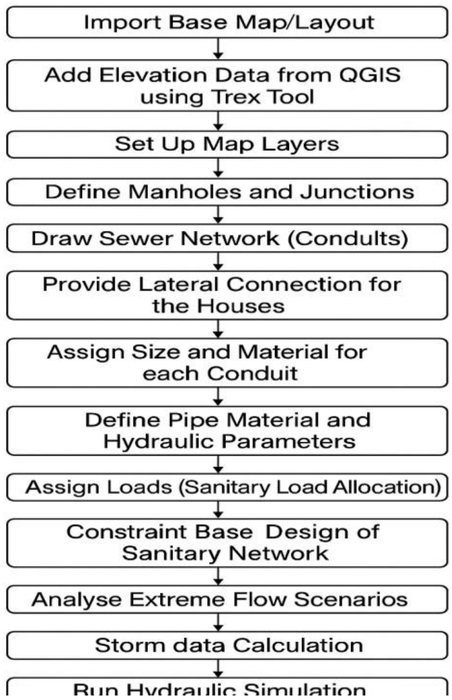

Fig. 4. Workflow of sewerage network

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V RESULTS

A.CONDUITS

Table 5 presents the detailed hydraulic characteristics of the designed conduits in the Hangal Town sewerage network. Each conduit is described with its ID, start and stop nodes, material, size, and Manning's roughness coefficient. The table also provides velocity, flow, depth-to-diameter ratio, and pipe length values.

The results indicate that:

- The minimum pipe diameter adopted was 150 mm, and the maximum was 1800 mm, as per CPHEEO guidelines.
- Manning's roughness coefficient was taken as n = 0.013, suitable for concrete pipes.
- Velocities across the network were maintained between 0.6–3.0 m/s, ensuring self-cleansing conditions and preventing scouring.
- The flow values demonstrate that the designed system can accommodate both present and projected future sewage loads.

	ID	Label	Start Node	Stop Node	Conduit Type	Material	Velocity (m/s)	Size	Depth/Rise (%)	Manning's n	Flow (m³/s)	Length (Scaled) (m)
75: m-6	75	m-6	J-30	J-29	Catalog Conduit	Concrete	1.7624	600 mm	100.0	0.013	0.4983	18.5
85: m-16	85	m-16	J-27	J-25	Catalog Conduit	Concrete	1.6794	600 mm	100.0	0.013	0.4748	19.1
71: m-2	71	m-2	J-31	J-37	Catalog Conduit	Concrete	1.3155	500 mm	100.0	0.013	0.2583	40.0
79: m-10	79	m-10	J-36	J-33	Catalog Conduit	Concrete	1.0102	500 mm	100.0	0.013	0.1984	31.7
84: m-15	84	m-15	J-26	J-27	Catalog Conduit	Concrete	1.1943	500 mm	100.0	0.013	0.2345	14.9
91: m-19	91	m-19	J-38	J-25	Catalog Conduit	Concrete	1.7118	500 mm	100.0	0.013	0.3361	33.6
93: m-21	93	m-21	manhole-21	manhole-20	Catalog Conduit	Concrete	1.4063	500 mm	100.0	0.013	0.2761	56.2
72: m-3	72	m-3	J-37	manhole-8	Catalog Conduit	Concrete	2.6622	900 mm	100.0	0.013	1.6936	52.5
76: m-7	76	m-7	J-29	J-3	Catalog Conduit	Concrete	1.1990	900 mm	100.0	0.013	0.7628	20.6
80: m-11	80	m-11	J-33	J-35	Catalog Conduit	Concrete	0.6711	900 mm	100.0	0.013	0.4270	20.4
81: m-12	81	m-12	J-35	J-42	Catalog Conduit	Concrete	1.1812	900 mm	100.0	0.013	0.7515	28.9
86: m-17	86	m-17	J-25	manhole-12	Catalog Conduit	Concrete	1.6237	900 mm	100.0	0.013	1.0330	38.9
82: m-13	82	m-13	J-42	J-41	Catalog Conduit	Concrete	0.9564	1200 mm	100.0	0.013	1.0817	54.1
87: m-18	87	m-18	manhole-12	manhole-11	Catalog Conduit	Concrete	1.1046	1200 mm	100.0	0.013	1.2493	50.2
274: CO-38	274	CO-38	J-3	J-37	Catalog Conduit	Concrete	0.9560	1200 mm	100.0	0.013	1.0813	66.2
96: m-24	96	m-24	manhole-24	manhole-25	Catalog Conduit	Concrete	2.3788	1800 mm	100.0	0.013	6.0532	106.5
97: m-25	97	m-25	manhole-25	manhole-26	Catalog Conduit	Concrete	2.4966	1800 mm	100.0	0.013	6.3532	160.0
98: m-26	98	m-26	manhole-26	O-1	Catalog Conduit	Concrete	2.8689	1800 mm	85.7	0.013	6.6592	129.5
73: m-4	73	m-4	manhole-8	manhole-11	Catalog Conduit	Concrete	1.7236	1600mm	100.0	0.013	3.4655	50.3
74: m-5	74	m-5	manhole-11	manhole-20	Catalog Conduit	Concrete	2.4495	1600mm	100.0	0.013	4.9249	38.5
83: m-14	83	m-14	J-41	manhole-8	Catalog Conduit	Concrete	0.7082	1600mm	100.0	0.013	1.4238	26.7
94: m-22	94	m-22	manhole-20	manhole-23	Catalog Conduit	Concrete	2.7211	1600mm	100.0	0.013	5.4711	45.4
95: m-23	95	m-23	manhole-23	manhole-24	Catalog Conduit	Concrete	2.8644	1600mm	100.0	0.013	5.7592	236.5

Fig. 5. SewerGEMS model showing layout of conduits

B. MANHOLES

ID, Label, Ground Elevation, Rim Elevation, Count of Sanitary Load, Type of Sanitary Load and Inflow Connection, Head Loss Method, Chances of Overflow.

	ID	Label	Elevation (Ground) (m)	Elevation (Rim) (m)	Flow (Total In) (m³/s)	Flow (Total Out) (m³/s)	Depth (Out) (m)	Hydraulic Grade Line (Out) (m)	Hydraulic Grade Line (In) (m)
35: manhole-11	35	manhole-11	584.00	584.00	4.9249	4.9249	4.14	4.14	4.14
36: manhole-12	35	manhole-12	583.00	583.00	1.2492	1.2492	4.19	4.19	4.19
45: manhole-20	45	manhole-20	583.00	583.00	5.4711	5.4711	4.01	4.01	4.01
46: manhole-21	46	manhole-21	582.00	582.00	0.2761	0.2761	4.31	4.31	4.31
48: manhole-23	48	manhole-23	582.00	582.00	5.7592	5.7592	3.82	3.82	3.82
49: manhole-24	49	manhole-24	575.00	575.00	6.0532	6.0532	2.70	2.70	2.70
50: manhole-25	50	manhole-25	572.00	572.00	6.3532	6.3532	2.41	2.41	2.41
51: manhole-26	51	manhole-26	571.00	571.00	6.6592	6.6592	1.92	1.92	1.92
58: manhole-8	58	manhole-8	584.00	584.00	3.4655	3.4655	4.23	4.23	4.23

Fig. 6. Manhole hydraulic performance data from SewerGEMS

C. LATERAL

ID, start nodes, end nodes, length, dia, and slope

	ID	Start Node	Stop Node	Diameter (mm)	Length (Scaled) (m)
186: L-1	186	PC-40	Tap-1	305	17.8
191: L-4	191	PC-38	Tap-3	305	16.1
193: L-5	193	PC-50	Tap-4	305	18.3
195: L-6	195	PC-43	Tap-5	305	9.8
197: L-7	197	PC-42	Tap-6	305	9.2
199: L-8	199	PC-41	Tap-7	305	10.5
201: L-9	201	PC-39	Tap-8	305	23.7
212: L-13	212	PC-45	Tap-12	305	11.9
214: L-14	214	PC-47	Tap-13	305	12.1
216: L-15	216	PC-44	Tap-14	305	8.7
218: L-16	218	PC-51	Tap-15	305	10.9
220: L-17	220	PC-48	Tap-16	305	7.7
222: L-18	222	PC-69	Tap-17	305	8.3
224: L-19	224	PC-68	Tap-18	305	7.9
226: L-20	226	PC-54	Tap-19	305	7.4
228: L-21	228	PC-53	Tap-20	305	8.0
230: L-22	230	PC-55	Tap-21	305	11.6
232: L-23	232	PC-65	Tap-22	305	7.3
234: L-24	234	PC-66	Tap-23	305	5.2
236: L-25	236	PC-67	Tap-24	305	7.2
238: L-26	238	PC-34	Tap-25	305	2.2
240: L-27	240	PC-35	Tap-26	305	7.1
241: L-28	241	PC-36	Tap-8	305	9.2
243: L-29	243	PC-37	Tap-27	305	6.8
245: L-30	245	PC-30	Tap-28	305	15.9
251: L-33	251	PC-56	Tap-31	305	25.3
259: L-37	259	PC-33	Tap-35	305	7.1
261: L-38	261	PC-62	Tap-36	305	11.0
263: L-39	263	PC-61	Tap-37	305	9.3
265: L-40	265	PC-58	Tap-38	305	11.4
267: L-41	267	PC-59	Tap-39	305	11.5
269: L-42	269	PC-60	Tap-40	305	11.7
276: L-44	276	PC-1	Tap-42	305	10.5
278: L-45	278	PC-2	Tap-43	305	9.7
282: L-47	282	PC-31	Tap-45	305	22.6
284: L-48	284	PC-32	Tap-46	305	9.6
286: L-49	286	PC-64	Tap-47	305	18.6
290: L-51	290	PC-57	Tap-49	305	13.8

Fig. 7. SewerGEMS flex table output showing lateral

D. TAPS

Id, Label, referenced link, type of unit, sanitary load, sanitary pattern, elevation.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 10, October - 2025

	ID	Label	Referenced Link	Distance from End Point (Scaled) (m)	Elevation (Connection) (m)
185: Tap-1	185	Tap-1	m-14	15.1	0.80
190: Tap-3	190	Tap-3	m-19	6.9	0.25
192: Tap-4	192	Tap-4	m-19	12.8	0.25
194: Tap-5	194	Tap-5	m-19	23.9	0.25
196: Tap-6	196	Tap-6	m-18	6.4	0.60
198: Tap-7	198	Tap-7	m-18	35.1	0.60
200: Tap-8	200	Tap-8	m-13	48.4	0.60
211: Tap-12	211	Tap-12	m-21	9.6	0.25
213: Tap-13	213	Tap-13	m-21	25.7	0.25
215: Tap-14	215	Tap-14	m-21	44.2	0.25
217: Tap-15	217	Tap-15	m-18	29.5	0.60
219: Tap-16	219	Tap-16	m-18	19.3	0.60
221: Tap-17	221	Tap-17	m-5	15.4	0.80
223: Tap-18	223	Tap-18	m-5	29.5	0.80
225: Tap-19	225	Tap-19	m-22	11.0	0.80
227: Tap-20	227	Tap-20	m-22	27.0	0.80
229: Tap-21	229	Tap-21	m-21	6.4	0.25
231: Tap-22	231	Tap-22	m-4	40.2	0.80
233: Tap-23	233	Tap-23	m-4	21.3	0.80
235: Tap-24	235	Tap-24	m-4	14.6	0.80
237: Tap-25	237	Tap-25	m-12	21.3	0.45
239: Tap-26	239	Tap-26	m-13	28.9	0.60
242: Tap-27	242	Tap-27	m-14	20.2	0.80
244: Tap-28	244	Tap-28	m-12	6.3	0.45
250: Tap-31	250	Tap-31	m-12	9.1	0.45
258: Tap-35	258	Tap-35	m-6	10.1	0.30
260: Tap-36	260	Tap-36	m-2	7.1	0.25
262: Tap-37	262	Tap-37	m-2	29.2	0.25
264: Tap-38	264	Tap-38	m-3	40.5	0.45
266: Tap-39	266	Tap-39	m-3	21.0	0.45
268: Tap-40	268	Tap-40	m-3	10.3	0.45
275: Tap-42	275	Tap-42	CO-38	4.2	0.60
277: Tap-43	277	Tap-43	CO-38	11.3	0.60
281: Tap-45	281	Tap-45	CO-38	34.9	0.60
283: Tap-46	283	Tap-46	CO-38	8.4	0.60
285: Tap-47	285	Tap-47	m-16	5.0	0.30
289: Tap-49	289	Tap-49	m-3	29.6	0.45

Fig. 8. Tap table output (SewerGEMS)

E. Summary Scenario

- The SewerGEMS scenario summary (Base Scenario) highlights the model configuration and solver settings, including dynamic wave routing, surcharge method, and conduit slope specifications.
- The gravity hydraulics and SWMM dynamic parameters, such as Manning's roughness, convergence tolerance, and time step increments, were applied to ensure stable and reliable simulation results.

Scenario Summary Report
Scenario: Base
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Scenario Summary	
ID	1
Label	Base
Notes	
Active Topology	Base Active Topology
User Data Extensions	Base User Data Extensions
Physical	Base Physical
Boundary Condition	Base Boundary Condition
Initial Settings	Base Initial Settings
Hydrology	Base Hydrology
Output	Base Output
Infiltration and Inflow	Base Infiltration and Inflow
Rainfall Runoff	Base Rainfall Runoff
Water Quality	Base Water Quality
Sanitary Loading	Base Sanitary Loading
Headloss	Base Headloss
Operational	Base Operational
Design	Base Design
System Flows	Base System Flows
SCADA	Base SCADA
Energy Cost	Base Energy Cost
Surface Definition	Base Surface Definition
Solver Calculation Options	Base Calculation Options

Hydraulic Calculation Events

Use	Start Date	Start Time	End Date	End Time

Explicit Results Control			
Catchments Results Type	All Results	Links Results Type	All Results
Nodes Results Type	All Results	Report Average Results?	False

Explicit Solver			
Routing Method	Dynamic Wave	Minimum Conduit Slope	0.000 m/m
Surcharge Method	Extran	Use Bentley Transition Equation?	False
Allow Ponding at Gravity Structures	True	SWMM Pattern Mode	Use SWMM Patterns.
Skip Steady State Periods?	False	Solver Compatibility	SWMM (BENTLEY 5.1.015)
Apply SWMM Control Set?	False		

Gravity Hydraulics

Scenario: Base
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Gravity Hydraulics			
Tractive Stress (Global Minimum)	0.000 Pascals		

Inlets			
Inlet Transition Depth	0.00 m	Split Downstream Surface Flow Between Gutters?	False

Grating Parameters (United Kingdom)

Grating Type	Grating Parameter
P	30.000
Q	45.000
R	60.000
S	80.000
T	110.000

Pressure Hydraulics			
Pressure Friction Method	Hazen-Williams		

Rational Method			
Use Rational Method Frequency Factors	False	Allow Runoff Coefficient to Exceed 1.0?	False

SWMM Dynamic			
Head Convergence Tolerance	0.2 cm	Define Super Critical Flow	Froude And Slope
Max Trials per Time Step	8	Minimum Surface Area	0.000 ha
Inertial Terms	Keep	Time Step For Conduit Lengthening	0.0 sec
Use Variable Time Step?	True	Minimum Variable Time Step	0.5 sec
Time Step Multiplier	75.0 %	Number of Threads	4

SWMM Hydrology			
SWMM Hydrologic Increment	0.250 hours	Start Sweeping On	01-01-2000
Antecedent Dry Period	0.0 days	End Sweeping On	31-12-2000
Dry Step	1.000 hours		

SWMM Interface Files			
Rainfall File Mode	None	Save Hot Start File?	False
Runoff File Mode	None	Use Inflow File?	False
RDII File Mode	None	Save Outflow File?	False
Use Hot Start File?	False		

Scenario Summary Report
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Water Quality			
Run Hydrogen Sulfide Analysis?	False		

HEC-22 Energy Losses			
Consider Non-Piped Plunging Flow?	True		

HEC-22 Energy Losses (Third Edition)			
Flat Submerged Coefficient	-0.050	Half Bench Unsubmerged Coefficient	-0.850
Flat Unsubmerged Coefficient	-0.050	Full Bench Submerged Coefficient	-0.250
Depressed Submerged Coefficient	0.000	Full Bench Unsubmerged Coefficient	-0.930
Depressed Unsubmerged Coefficient	0.000	Improved Submerged Coefficient	-0.600
Half Bench Submerged Coefficient	-0.050	Improved Unsubmerged Coefficient	-0.980

Operational (SCADA)			
PIpe Blockages	None		

Fig. 9. Base scenario configuration using SWMM solver in SewerGEMS

VI SUMMARY AND CONCLUSION

This study focuses on the design and hydraulic analysis of the sewerage network for Hangal Town using SewerGEMS, integrated with QGIS and guided by CPHEEO and IS codes. The project involved data collection, GIS base map preparation, estimation of sewage generation (3.67 MLD for 2025 and 5.02 MLD for 2055), and design of the sewer network including conduits, manholes, and pumping stations. Hydraulic analysis was performed using Manning's and Hazen-William's equations, and verified through SewerGEMS simulations ensuring non-surcharged flow conditions (Depth/Rise ≤ 1). Manual and software results showed high consistency, confirming model reliability.

The developed network offers a scientifically planned and hydraulically optimized solution for Hangal Town, ensuring efficient wastewater collection, minimal environmental impact, and compliance with engineering standards. SewerGEMS proved to be an effective tool for accurate, sustainable, and technology-driven design, simplifying the network development process and supporting long-term urban sanitation planning.

A. Scope for Future Work

- Integration of sewer and stormwater networks to reduce flooding.
- Real-time monitoring and seasonal flow simulations.
- Proper siting and capacity planning of sewage treatment plants (STPs).
- Reuse of treated wastewater for agriculture and industry.
- Consideration of climate change impacts and green infrastructure.
- Life-cycle cost analysis and adoption of energy-efficient systems.
- PPP models for funding and GIS/IoT-based smart sewer monitoring.

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